HIGH SCHOOL PHYSICS
1st Semester

ASSIGNMENT #19 Name Key

Work the following problems on circular motion showing all your work in the space provided.

AP/R

1. A mass moves in a circular path with a speed of 1.50 m/s and has a centripetal acceleration of 3.00 m/s². What is the radius of the circular path of the mass?

$a_c = \frac{v^2}{r} \rightarrow r = \frac{v^2}{a_c}$ Ans. $r = .75 m$

$\frac{(1.5 m/s)^2}{3 m/s^2} = .75 m$

AP/R

2. A cord 0.75 m long exerts a centripetal force of 12.0 N on a whirling stone of mass 0.15 kg tied to the end of the cord. What is the velocity of the whirling stone?

Ans. 7.75 m/s

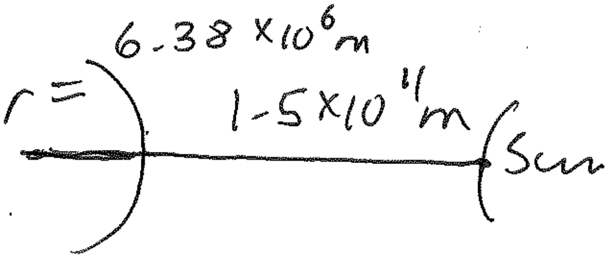
$F_c = \frac{mv^2}{r}$

$v = \sqrt{\frac{F_c r}{m}} = \sqrt{\frac{12 N \cdot .75 m}{.15 kg}} = v$

AP

3. The earth orbits the sun at a distance of 1.50 x 10¹¹ m. What is the centripetal ~~acceleration~~ force of the earth in this orbit? What is the centripetal force and what provides this force? (Mass of the earth is 5.98 x 10²⁴ kg.)

Ans. $3.56 \times 10^{22} N$ Gravity



$F_c = \frac{mv^2}{r} = \frac{M_e \cdot \left(\frac{2\pi r}{T}\right)^2}{r}$

$F_c = \frac{5.98 \times 10^{24} kg \cdot \left(\frac{2\pi \cdot 1.5 \times 10^{11} m}{(365 \cdot 24 \cdot 60 \cdot 60)}\right)^2}{1.5 \times 10^{11} m}$ → # of sec in 1 year

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ASSIGNMENT #20 Name ______________________

Work the following problems on circular motion showing all your work in the space provided.

AP/R 1. An amusement park ride consists of a turntable of 2.00 m radius turning at 7.00×10^{-1} revolutions per second. If a 70.0 kg child sits at the outer edge of the turntable, what force is necessary to keep the child from sliding off? What is the direction of the force?

Ans. $F_c = 2708.22\,N$

Friction or a harness

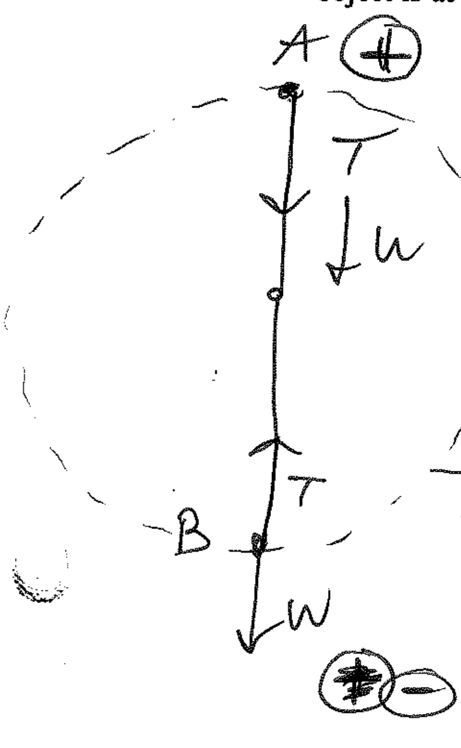
$F_c = \frac{mv^2}{r} = 70kg \cdot \left(\frac{v^2}{r}\right)$

$V = \frac{2\pi r}{1\,rev} \cdot \frac{.7\,rev}{1\,sec} = \frac{8.8\,m}{sec} = V$

so $\frac{70kg\,(8.8\,m/s)^2}{2} = F_c$

AP/R 2. A 2.00 kg object is attached to a 1.50 m long string and swung in a vertical circle at a constant speed of 12.0 m/s. (a) What is the tension in the string when the object is at the top of its path? (b) What is the tension in the string when the object is at the bottom of its path?

Ans. (a) 172.4 N
(b) 211.6 N



$\Sigma F_c = -T - W = \frac{mv^2}{r}$

$-T = -\frac{mv^2}{r} + W$ so $T = \frac{mv^2}{r} - W$

$T = \frac{2(12\,m/s)^2}{1.5\,m} - 2(9.8) = 172.4\,N$

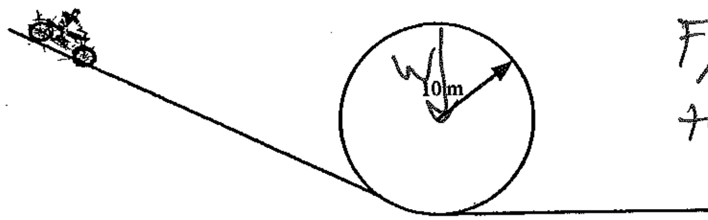
$\Sigma F_c = T - W = \frac{mv^2}{r}$ $T = 211.6\,N$

so $T = \frac{mv^2}{r} + W = T = \frac{2\cdot(12)^2}{1.5} + 2\cdot 9.8$

AP

3. A carnival stunt rider rides a motorcycle down a ramp and around a "loop-the-loop" as shown in the diagram. If the loop has a radius of 10.0 meters, what is the minimum speed the rider can have at the top of the loop and avoid falling? The mass of the motorcycle is 2.50×10^2 kg and the mass of the rider is 55 kg.

Ans. 9.9 m/s



$F_N = 0$ = weightlessness the W provides the F_c for continued circular motion.

$$\Sigma F_c = -W = -\frac{mv^2}{r}$$

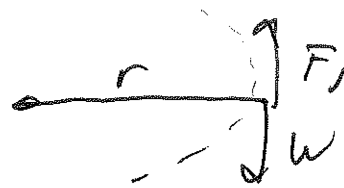
$$W = \frac{mv^2}{r}$$

$$\frac{(10m)(250kg + 55kg) \cdot 9.8m/s^2}{(250 + 55)} = v^2 \text{ so } v = 9.9 m/s$$

4. Friction provides the centripetal force necessary for a car to travel around a flat circular race track. What is the maximum speed at which a car can safely travel around a circular track of radius 80.0 meters if the coefficient of friction between the tire and road is 0.35?

Ans. $v = 16.57 m/s$

$$\Sigma F_c = F_s = \frac{mv^2}{r}$$



$$F_s = \mu_s \cdot F_N$$

so

$$\mu_s F_N = \frac{mv^2}{r} \qquad F_N = W = mg$$

so

$$\mu_s \cdot mg = \frac{mv^2}{r} = \mu_s g = \frac{v^2}{r}$$

$$v = \sqrt{\mu_s \cdot g \cdot r} = v = 16.57 m/s$$

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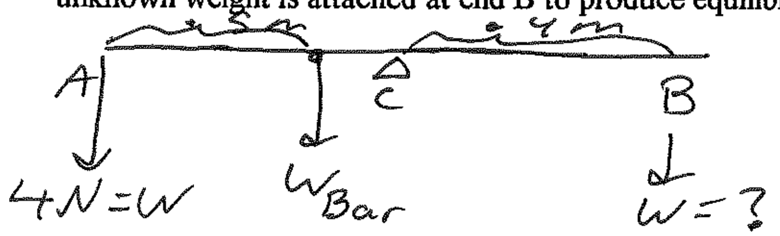
ASSIGNMENT #21 Name ______________________________

Work the following problems on torque showing all your work in the space provided.

1. Carefully draw a diagram for the following arrangement. A uniform bar AB, weighing 5.00 newtons, is 1.00 meters long and rotates about a fixed point C, which is 40.0 cm from end B. A weight of 4.00 N is attached at end A and an unknown weight is attached at end B to produce equilibrium.



(a) What is the clockwise torque about point C?

Clockwise = +

so $W_A \times .6 + W_{Bar} \times .1 =$

Ans. $\tau = 2.9$ N·m

(b) What is the counterclockwise torque?

$W_B \times L = W \times .4m$

Ans. $W_B * .4m$

2.9 N·m

(c) If the bar is in equilibrium, how must these two torques compare?

Ans. $\Sigma\tau = 0$

(d) What is the magnitude of the unknown weight attached to end B?

Ans. $W_B =$ ~~4.33 N~~

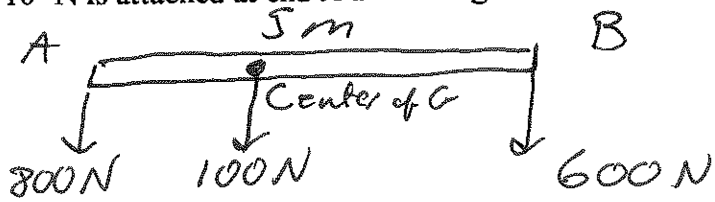
$W_B = 7.25 N$

$\Sigma\tau = 0$

Thus

$-(W_A \times .6) - (W_{Bar} \times .1) + (W_B \times .4) = 0$

2. Carefully draw a diagram for the following arrangement. A bar AB, weighing 1.00×10^2 N, is 5.00 meters long. Its center of gravity is 2.00 meters from end A. A weight of 8.00×10^2 N is attached at end A and a weight 6.00×10^2 N is attached at end B.



(a) What is the magnitude of the upward **equilibrant** force?

Ans. 1500 N

$\Sigma F_y = -800 - 100 - 600 + F_E = 0$

$F_E = 1500 N$

(b) Using A as the axis of rotation, what is the clockwise torque?

Ans. $+ F_E \times l$

The equilibrium force only

(c) What is the counterclockwise torque about point A?

Ans. $\tau = -3200$ N·m

$\tau_{Bar} = 100 N \times 2 m$

$\tau_B = 600 N \times 5 m$

(d) How far from end A must the upward equilibrant force act to place the bar in equilibrium?

Ans. $2.1\overline{3}$ m

$\Sigma \tau = 0$

So

$\Sigma \tau = -3200$ N·m $+ 1500 N \times l = 0$

~~counter~~ clockwise

$l = 2.1\overline{3}$ m

HIGH SCHOOL PHYSICS
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ASSIGNMENT #24 Name ____________________

Work the following problems on planetary motion showing all your work in the space provided.

Ap

1. Kepler's law states that R^3/T^2 is a constant with a value of $3.35 \times 10^{18}\ m^3/s^2$. How many years would it take a planet located five times as far from the sun as the earth to orbit the sun? (Distance from the earth to the sun is equal to 1.496×10^{11} m.)

Ans. 11.2 years

R_E = earth
R_N = new

$$\frac{R_E^3}{T_E^2} = \frac{R_N^3}{T_N^2}$$

$$T_N^2 \cdot R_E^3 = R_N^3 \cdot T_E^2 \quad \text{so} \quad T_N = \sqrt{\frac{R_N^3 \cdot T_E^2}{R_E^3}}$$

$$R_N = 5 \cdot 1.496 \times 10^{11}\ m$$

$$T_E = 24 \cdot 365 \cdot 60 \cdot 60\ sec$$

Ap

2. If we know that it takes Jupiter 11.86 years to orbit the sun, what is the mean distance Jupiter is from the sun?

Ans. $R_J = 3.41 \times 10^{11}$ m
7.7×10^{11}

$$\frac{R_E^3}{T_E^2} = \frac{R_J^3}{T_J^2}$$

$$\frac{(1.496 \times 10^{11}\ m)^3}{(365 \cdot 24 \cdot 60 \cdot 60)^2} = \frac{R_J^3}{(11.86 \cdot 365 \cdot 24 \cdot 60 \cdot 60)^2}$$

X

3. A satellite and the moon both obit the earth so we can apply Kepler's third law. An isochronous satellite of the earth is a satellite the remains above the same point on the equator of the earth. What is the height above the earth's surface for such a satellite? (The distance the moon is from the earth is 380,000 km and it has a period of 27 days.)

Ans. ~~__________~~

$$\frac{R_M^3}{T_M^2} = \frac{R_S^3}{T_S^2}$$

$$\frac{(3.8 \times 10^8\ m)^3}{(~~27\ days~~)^2} = \frac{R_S^3}{1\ day}$$

$27 \cdot 24 \cdot 3600$

HIGH SCHOOL PHYSICS
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ASSIGNMENT #25 Name ____________________

Work the following problems on Universal Gravitation showing all your work in the space provided.

1. A sphere of mass 75 kg is 15.2 meters from a second sphere of mass 97 kg. What is the gravitational force of attraction between the spheres?

Ans. 2.156×10^{-9} N

$$F = \frac{G \cdot M_1 \cdot M_2}{r^2}$$

$$\frac{6.67 \times 10^{-11} \cdot 75 kg \cdot 97 kg}{(15.2 m)^2}$$

2. What is the acceleration due to gravity (g) on the surface of Mars? If you weigh 587 N on the earth's surface, how much would you weigh on the surface of the planet Mars? (Mars has a mass of 6.37×10^{23} kg and a radius of 3.43×10^6 m.)

Ans. (a) $3.61 m/s^2$
(b) $W = 216.3$ N

$$F = \frac{G \cdot M_p \cdot m}{r_p^2} \approx F = ma$$

$W = mg$

$m = 59.9$ kg

on mars

$W = mg$

$W = (59.9 kg) \cdot 3.61$

$$a_g \quad \frac{6.67 \times 10^{-11} \cdot 6.37 \times 10^{23} kg}{(3.43 \times 10^6 m)^2} = 3.61 m/s^2 = a_g$$

3. What would be the period of a 2.00 meter long pendulum on the surface of Mars?

Ans. ____________

HIGH SCHOOL PHYSICS
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ASSIGNMENT #26 Name ____________________

Work the following problems on Universal Gravitation showing all your work in the space provided.

Not actual
1.9×10^{27} kg.

1. One of the moons of Jupiter is Callisto. It has a mean distance of 1.883×10^6 km from Jupiter and has a period of 16.7 days. What is the mass of Jupiter?

Assume 1.883×10^9 m is r

Ans. ~~1.008×10^{18}~~ kg

T = 16.7 days → 1,442,880 sec

$V = \frac{2\pi r}{T}$

and

$\frac{mv^2}{r} = \frac{G \cdot m M_p}{r^2}$ so $\frac{v^2 r}{G} = M_p$ and so $\frac{\left(\frac{2\pi r}{T}\right)^2}{G} = M_p$

2. Calculate the velocity of a satellite that is 3200 km above the surface of the earth. What is the period of such a satellite?

Ans. (a) 6,452.5 m/s
(b) 9,328.56 sec

$F_c = F_G$ so $\frac{mv^2}{r} = \frac{G \cdot M_e \cdot m}{r^2}$

$T = \frac{2\pi r}{V} = \frac{2 \cdot \pi \cdot (r_E + r_O)}{6452.5 \text{ m/s}}$

thus

$\frac{v^2}{r} = \frac{G M_e}{r^2}$ and

T = 9,328.56 sec

$V = \sqrt{\frac{G \cdot M_e}{r}} = \sqrt{\frac{6.67 \times 10^{-11} \cdot M_e}{(6.38 \times 10^6 m + 3,200,000 m}} = 6452.5$ m/s

3. What would be the speed and period of the satellite in problem #2 if the altitude was reduced by 1/2 to 1600 km?

Ans. (a) 15,788.96 m/s
(b) 3175.63 sec

$V = \sqrt{\frac{6.67 \times 10^{-11} \cdot 5.98 \times 10^{24} \text{ kg}}{(6.38 \times 10^6 m + 1800000 m)}}$

V = 15,788.96 m/s

$T = \frac{2\pi (r_E + r_O)}{V}$

T = 3175.63 sec